SUSQUEHANNA RIVER BASIN

TRIBUTARY TO ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LEVEL II

ELMCREST DAM

NDI ID NO. PA-00347

DER ID NO. 35-142

MRS. LOUISE BOEZI

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105
Frederick Futchko

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1981

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DACW31-81-C-0018

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PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

ELMCREST DAM

NDI ID No. PA-00347; DER ID No. 35-142

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Elmcrest Dam NDI ID No. PA-00347 DER ID No. 35-142
Size:	Small (8.9 feet high; 283 acre-feet)
Hazard Classification:	Significant
Owner:	Mrs. Louise Boezi RD 2 Moscow,PA 18444
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Tributary to Roaring Brook
Date of Inspection:	2 June 1981

Based on the criteria established for these studies, Elmcrest Dam is judged to be in fair condition. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between the 100-year flood and 1/2 of the Probable Maximum Flood (PMF). The selected SDF is the 1/2 PMF. The existing spillway will pass only about 40 percent of the PMF before overtopping of the dam occurs. The spillway capacity is rated as inadequate. The computed spillway capacity is, at best, a rough approximation. It is judged that there is a severe potential for collection of debris at the spillway which could reduce the spillway capacity considerably.

The outlet works is only capable of discharging when the reservoir is above normal pool elevation. Access to the outlet works valve is judged to be unsuitable. No conditions of immediate concern were observed at the embankment.

The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay:

(1) Design and construct a spillway capable of passing the SDF. The spillway should be designed so as to eliminate both the potential for collection of debris and the potential for erosion at the embankment.

(2) Remove debris and clear trees and brush on or adjacent to the embankment.

(3) Modify the outlet works so that it is capable of drawing down the reservoir in case of an emergency, or develop another method for drawing down the reservoir in case of an emergency.

(4) Visually monitor the depression on the top of the embankment. If changes are noted, implement remedial action.

All designs and construction inspection should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the Owner should develop the following operational and maintenance procedures.

(1) Develop a detailed emergency operation and warning system for the dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

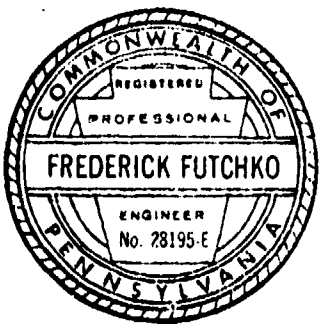
(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) As presently required by the Commonwealth, initiate a program of formal annual inspections by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary. During annual inspections, particular attention should be given to possible seepage problems at the bait ponds and swamp located at the toe of the embankment and to the depression at the top of the embankment.

(4) Continue the current maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

ELMCREST DAM

Submitted by:



GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 7 August 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date: 18 Aug 81

ELMCREST DAM

Overview

ELMCREST DAM

NDI ID No. PA-00347; DER ID No. 35-142

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Elmcrest Dam is a homogeneous earthfill structure. It is 345 feet long and 8.9 feet high. The top width varies between 22 and 47 feet. The upstream slope is about 1V on 2.9H; the downstream slope is about 1V on 2.3H.

The spillway is located at the left abutment of the dam. It is a trapezoidal-shaped earthen channel. The right side slope is 1V on 2H. The bottom width of the spillway is 6.5 feet. On the bottom of the spillway, at the left side, are two 15-inch diameter corrugated metal pipes (CMP) placed parallel to the spillway axis. Adjacent to and to the left of the CMPs is a steel waterheater tank. A timber bridge crosses the spillway. The right end of the bridge is supported by the embankment; the left end of the bridge is supported by natural ground and by a water heater tank.

The outlet works is located near the middle of the embankment. It consists of an 8-inch diameter cast-iron pipe (CIP). At the upstream end a vertical riser extends to above normal pool. The valve to control the flow is located on this vertical riser beneath normal pool level.

The various features of the dam are shown on the photographs in Appendix C and on the plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Elmcrest Dam is located on a tributary to Roaring Brook about 1.0 mile above its confluence with Roaring Brook in Roaring Brook Township, Lackawanna County, Pennsylvania. The dam is about 4 miles northeast of Moscow. The dam is shown on the USGS Quadrangle, Olyphant, Pennsylvania, at latitude N 41° 23.0' longitude W 75° 31.8'. A location map is shown on Plate E-1.

c. Size Classification. Small (8.9 feet high, 283 acre-feet).

d. Hazard Classification. Downstream conditions indicate that a significant hazard classification is warranted for Elmcrest Dam (Paragraphs 3.1e and 5.1c (5)).

e. Ownership. Mrs. Louise Boezi, RD2, Moscow, PA 18444.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was designed and constructed during the early 1950's by Mr. Peter Boezi, the late husband of the Owner. A further description of the construction is in Section 2.

h. Normal Operational Procedure. The reservoir is maintained at spillway crest with inflow discharging over the spillway.

1.3 Pertinent Data.

a. Drainage Area. (square miles) 0.3

b. Discharge at Damsite. (cfs)

Maximum known flood	Unknown
Outlet works at maximum pool elevation	3
Spillway capacity at maximum pool elevation	92

c. Elevation. (feet above msl.)

Top of dam	1597.9
Maximum pool	1597.9
Normal pool (spillway crest)	1595.1
Upstream invert outlet works (approx.)	1596.0
Downstream invert outlet works (approx.)	1589.0
Streambed at toe of dam	1589.0

d.	Reservoir Length. (miles)	
	Normal pool (spillway crest)	0.42
	Maximum pool	0.43
e.	Storage. (acre-feet)	
	Natural Pond (approx.)	47
	Normal pool	174
	Maximum pool	283
f.	Reservoir Surface. (acres)	
	Natural Pond (approx.)	10
	Normal pool (spillway crest)	34
	Maximum pool	44
g.	Dam.	
	Type	Earthfill
	Length (feet)	345
	Height (feet)	8.9
	Topwidth (feet)	Varies, 22 to 47
	Side Slopes	
	Upstream	1V on 2.9H
	Downstream	1V on 2.3H
	Zoning	None
	Cutoff	None
	Grout Curtain	None
h.	Diversion and Regulating Tunnel.	None
i.	Spillway.	
	Type	Trapezoidal earthen channel.
	Length of Weir (feet - bottom width)	4, exclusive of two 15-inch diameter CMPs.

i.	Spillway. (cont'd.)	
	Crest Elevation	1595.1
	Upstream Channel	Earth-lined approach channel
	Downstream Channel	Stream through swamp
j.	Regulating Outlets.	
	Type	One 8-inch diameter CIP. Upstream invert is above normal pool elevation.
	Length (feet)	70
	Closure	Valve at upstream end
	Access	Valve is below normal pool and only accessible by swimmer

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. No design data were available. Plate E-2 in Appendix E was drawn from survey data obtained for this inspection.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the photographs in Appendix C and on the plates in Appendix E.

c. Design Considerations. Since there is no design information, the design cannot be assessed.

2.2 Construction Data.

a. Data Available. The available data was provided to the inspection team verbally by Mr. Frank August on the day of the inspection. Mr. August assisted Mr. Peter Boezi, the late husband of the Owner, in construction of the dam. Mr. August reported that construction of the dam took about 7 years. Much of the time was spent in clearing the reservoir area. The dam was completed prior to 1955. Mr. August was unsure of the date. Construction techniques consisted of removing a considerable amount of "peat" until the entire embankment foundation was "hardpan." Mr. August further described the "hardpan" as a stiff yellow clay. Similar clay, which also contained some "boulders," was used as the homogeneous embankment fill. Compaction was performed with a bulldozer and a roller. The CIP for the outlet works was not encased with concrete. It has flanged connections.

b. Construction Considerations. Although the construction techniques used were not wholly consistent with the standard engineering practice of the time, the techniques are deemed adequate considering the low height and wide topwidth of the embankment. There are insufficient data to assess the construction of the outlet works.

2.3 Operation. There are no formal records of operation. Mr. August reported that no problems have occurred over the operational history of the dam.

2.4 Evaluation.

a. Availability. Available data were provided verbally by Mr. Frank August, who represented the Owner during the visual inspection.

b. Adequacy. The type and amount of available design data and other engineering data are very limited, and the assessment is based on the combination of available data, visual inspection, performance history, hydrologic and hydraulic assumptions, and calculations developed for this report.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam and appurtenant structures is fair. Deficiencies were observed as noted below. A sketch of the dam with the locations of the deficiencies is presented on Exhibit B-1 in Appendix B. Survey information acquired for this Report is on Plate E-2 in Appendix E. Datum used for the survey was the spillway crest, Elevation 1595.1, as estimated from USGS contour mapping. On the day of the inspection, the pool elevation was 0.5 foot above the spillway crest level.

b. Embankment. The top of the embankment is covered with a stand of grass and is well maintained (Photograph A). There is a depression, about 15 feet in diameter, above the outlet works pipe (Photograph B). The depression extends from the axis of the dam to the downstream edge of the top of the dam. It is about 1.5 feet deep. The cause of the depression is unknown. It appears to be a localized settlement. Most of the upstream and downstream slopes are covered with mature trees and brush (Photograph B). In addition, some of the downstream slope is covered with a thick pile of grass clippings and other debris. Vegetation and debris obscured sections of the slopes. No deficiencies were observed on the unobscured sections of the upstream and downstream slopes.

Two bait ponds extend downstream from the embankment, as shown on Plate E-2. Both the outlet works and the spillway channel discharge into the leftmost bait pond (Photograph F). The area between this bait pond and the spillway is a swamp. The swamp, which is heavily overgrown, extends for a significant distance downstream from the embankment. No seepage areas were observed, although they could have been obscured by the pond, swamp, and flow from the spillway.

c. Appurtenant Structures. The outfall of the outlet works pipe is covered with silt and miscellaneous organic matter. The Owner's representative reported that the outlet works pipe protruded slightly from the toe of the embankment, but the inspection team was unable to locate it. The Owner's representative reported that it usually takes a swimmer to operate the outlet works valve.

A fish screen extends across the spillway approach channel (Photograph D). The Owner's representative reported that the screen is removed if a flood is reported to be imminent. The fish screen supports are not capable of withstanding any significant load.

A minor amount of debris is accumulated at the spillway (Photograph E). The CMPs in the spillway are corroded through. The area of natural ground to the left of the spillway is heavily overgrown with thick brush and small trees. The right side of the spillway is the embankment. It is covered with vegetation. The spillway exit channel is not well-defined as it extends through the swamp to the bait pond.

d. Reservoir Area. The watershed is primarily farm fields and woodlands with moderate to relatively flat slopes. The development within the watershed is minor and rural. The reservoir is a significant part of the watershed. The reservoir area was only partially cleared and many of the stumps are rotten. The Owner's representative reported that there was a natural pond at the upstream end of the reservoir before the dam was constructed. He reported that the existing reservoir is 20 feet deep in spots.

e. Downstream Conditions. From the dam the stream extends for 0.9 mile to Pennsylvania Route 590. This reach is relatively steep and all dwellings along it are well above streambed. Pennsylvania Route 590 crosses the stream on an embankment that is 20 to 25 feet high. The topwidth of the embankment is about 75 feet. The embankment also once conveyed a railroad; however, the tracks have been removed. The stream passes beneath the embankment in two culverts that are judged to have negligible capacity. Downstream from the embankment, the stream extends for about 300 feet to its confluence with Roaring Brook. The overbank area along this 300-foot long reach is very flat. Seven dwellings and one small unoccupied store are located in this area. The estimated effects of a failure of Elmcrest Dam are described in Section 5. A significant hazard classification has been assigned to Elmcrest Dam.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at spillway crest with excess inflow discharging over the spillway. The Owner's representative reported that the outlet works is used to augment spillway capacity in case of a flood. The fish screen in the spillway is removed if a flood is imminent.

4.2 Maintenance of Dam. The dam is visited daily by the Owner, who lives in a house at the right abutment. The grass on the top of the dam is mowed weekly. The need for other maintenance is determined by the Owner. Formal inspections of the dam are not made.

4.3 Maintenance of Operating Facilities. The outlet works operating mechanism is reportedly operated occasionally.

4.4 Warning Systems in Effect. There is no emergency warning system at the dam.

4.5 Evaluation of Operational Adequacy. The deficiencies noted in Section 3 indicate that the maintenance of the dam and appurtenant works needs improvement. The frequency of inspection by the Owner is good, but a program of formal annual inspection is necessary to detect potentially hazardous conditions. A formalized emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no hydrologic or hydraulic design data.

b. Experience Data. The Owner's representative stated that the largest known flood since the dam was constructed occurred in 1955 during Tropical Storm Diane. There were insufficient data to estimate the flow for this storm.

c. Visual Observations.

(1) General. The visual inspection of Elmcrest Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics. These observations are evaluated herein.

(2) Embankment. Except at the spillway, as discussed below, there are no deficiencies relevant to hydrology or hydraulics at the embankment.

(3) Appurtenant Structures. For low-flow conditions, the approach losses in the spillway approach channel are judged to be appreciable; this explains the 0.5 foot difference in head between the spillway crest elevation and the pool elevation on the day of the inspection, when the quantity of flow was relatively small. As the pool elevation increases, the approach losses should become insignificant. The fish screen in the approach channel is judged to have no significant effect because it would collapse during any significant flow. However, the spillway itself is judged to have a very large potential to collect debris during a flood. It is conceivable that sufficient debris could collect to completely block the spillway. There is an erosion potential at the right end of the spillway, which is the left end of the embankment.

The natural ground to the left of the spillway is lower than the top of the embankment. At present, it is judged to be too overgrown with brush and small trees to be effective in conveying any significant discharge.

Due to the unusual arrangement of the spillway, the calculations in Appendix D for the spillway capacity are, at best, a rough approximation. The effects of debris, approach losses, and tailwater have been ignored. The approach losses could have a significant effect on the

computed ability of the dam to pass its Spillway Design Flood (SDF) because surcharge storage could be significantly reduced at the onset of a flood. The spillway exit channel is not well-defined as it flows through the swamp. Some water would flow along the toe of the embankment. With the existing spillway capacity, no significant amount of erosion is anticipated.

The Owner's representative described the outlet works. It is capable of augmenting the spillway capacity only slightly. There is no facility capable of drawing down the pool in case of emergency. It is surmised that the outlet works pipe was used for diversion during construction. With some slight modifications to the intake facilities, the outlet works could be used to draw down the pool. Access to the valve is judged to be unsuitable, especially during the winter.

(4) Reservoir Area. No conditions in the watershed were observed that might present a hazard to the dam. The rotten stumps in the reservoir have a potential to become debris and block the spillway during a flood.

(5) Downstream Conditions. The downstream conditions are described in Section 3. A failure of Elmcrest Dam would cause water to pond upstream of the Pennsylvania Route 590 embankment. The top elevation of this embankment is very flat and a shallow sheet of water would flow over the embankment. The effect of the embankment would be to spread out water adjacent to seven dwellings and an unused store. Substantial property damage and basement flooding would result. Access to other dwellings would be inhibited. Because of the shallow flooding, it is judged that only a few lives would be in jeopardy. The downstream conditions indicate that a significant hazard classification is warranted for Elmcrest Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (significant) of Elmcrest Dam is between the 100-year flood and one-half of the Probable Maximum Flood (PMF). Because of the nature of the damage that could result from a failure of Elmcrest Dam, the 1/2 PMF is selected as the SDF. The watershed and reservoir were modeled with the U.S. Army Corps of Engineers HEC-1DB computer program. A description of the model is included in Appendix D. The assessment of hydrology and hydraulics is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that the existing Elmcrest Dam can pass about 40 percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix D. Because Elmcrest Dam cannot pass the 1/2 PMF, which is the SDF, the spillway capacity is rated as inadequate. If the dam were to fail during a flood, it is judged that a significant increase in damages downstream would occur.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Elmcrest Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Embankment. Brush and debris on the embankment are objectionable because they might obscure conditions that could be of concern. Trees are objectionable for the above reasons and also because the root systems can create seepage paths through the embankment.

The depression on top of the embankment would be of no concern if further settlement does not occur. Monitoring the depression is warranted. The bait ponds at the toe of the embankment could obscure seepage, although none was observed on the day of the inspection. The swamp near the left end appears to be a natural condition exacerbated by spillway flow.

(3) Appurtenant Structures. Although the pipes at the spillway are deteriorated, they do not affect the structural integrity of the dam. No structural deficiencies were observed at the outlet works.

b. Design and Construction Data. No stability analyses are available for the embankment. The available data are described in Section 2.

c. Operating Records. There are no formal records of operation. There is no information indicating any problems with the dam since its construction.

d. Post-construction Changes. There have been no post-construction changes.

e. Seismic Stability. Elmcrest Dam is located in Seismic Zone 1. Earthquake loadings are not considered to be significant for small dams located in Seismic Zone 1 when there are no readily apparent stability problems. Since there are no readily apparent stability problems, the ability of the embankment to withstand an earthquake is assumed to be adequate.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on available records, visual inspection, calculations, and past operational performance, Elmcrest Dam is judged to be in fair condition. Based on the size and hazard classification of the dam, the recommended SDF at the dam varies between the 100-year flood and the 1/2 PMF. The selected SDF is the 1/2 PMF. The spillway will pass about 40 percent of the PMF before overtopping of the dam occurs. The spillway capacity is rated as inadequate. The computed spillway capacity is, at best, a rough approximation. It is judged that there is a severe potential for collection of debris at the spillway.

(2) The outlet works is only capable of discharging when the reservoir is above normal pool elevation. Access to the outlet works valve is judged to be unsuitable.

(3) No conditions of immediate concern were observed at the embankment.

(4) A summary of features and observed deficiencies is as follows:

Feature	Observed Deficiency
Embankment:	Depressed area on embankment; brush, debris, and mature trees on slopes and at downstream toe.
Spillway:	Erosion hazard at embankment; potential for collection of debris.
Outlet Works:	Poor access; unable to draw down pool; outlet covered with silt and organic matter.

(b) Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed as a part of this study.

(c) Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

(d) Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will be required.

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay:

(1) Design and construct a spillway capable of passing the SDF. The spillway should be designed so as to eliminate both the potential for collection of debris and the potential for erosion at the embankment.

(2) Remove debris and clear trees and brush on or adjacent to the embankment.

(3) Modify the outlet works so that it is capable of drawing down the reservoir in case of an emergency, or develop another method for drawing down the reservoir in case of an emergency.

(4) Visually monitor the depression on the top of the embankment. If changes are noted, implement remedial action.

All designs and construction inspection should be performed by a professional engineer experienced in the design and construction of dams.

b. In addition, the Owner should develop the following operational and maintenance procedures.

(1) Develop a detailed emergency operation and warning system for the dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) As presently required by the Commonwealth, initiate a program of formal annual inspections by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary. During annual

inspections, particular attention should be given to possible seepage problems at the bait ponds and swamp located at the toe of the embankment and to the depression at the top of the embankment.

(4) Continue the current maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: ELMCREST

NDI ID NO.: PA-00347 DER ID NO.: 35-142

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	NONE FOR PLAN, SEE PLATE E-2
REGIONAL VICINITY MAP	See PLATE E-1
CONSTRUCTION HISTORY	As Recounted by Mr. Frank August. See Section 2 of Report.
TYPICAL SECTIONS OF DAM	See PLATE E-2
OUTLETS: Plan Details Constraints Discharge Ratings	NONE

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	NONE
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	NONE
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	NONE

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Reservoir Area
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	Tropical Storm Diane in 1955 No high water mark.
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	NONE
SPILLWAY: Plan Sections Details	See PLATE E-2
OPERATING EQUIPMENT: Plans Details	NO PLANS OR DETAILS
PREVIOUS INSPECTIONS Dates Deficiencies	NONE

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: ELMCREST **County:** LACKAWANNA **State:** PENNSYLVANIA

NDI ID No.: PA-00347 **DER ID No.:** 35-142

Type of Dam: EARTHFILL **Hazard Category:** SIGNIFICANT

Date(s) Inspection: 2 JUNE 1981 **Weather:** HAZY - MISTY **Temperature:** 60's °F

SOIL CONDITIONS: MOIST TO WET

Pool Elevation at Time of Inspection: 1595.6 msl/**Tailwater at Time of Inspection:** 1590.0 msl

Inspection Personnel:

FRANK AUGUST (RELATIVE OF OWNER)

D. WILSON (GFCC)

D. EBERSOLE (GFCC)

A. WHITMAN (GFCC) **Recorder**

B-1

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	NONE	
CREST ALIGNMENT: Vertical Horizontal	HORIZONTAL - NO DEFICIENCIES VERTICAL - SEE PLATE E-2	
RIPRAP FAILURES	NONE	

B-2

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	No deficiencies at abutment. Only vegetal cover at junction embankment and spillway.	Erosion potential
ANY NOTICEABLE SEEPAGE	None	Bait ponds at toe
STAFF GAGE AND RECORDER	None	
DRAINS	None at site	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	CAST IRON PIPE 8" DIAMETER	
INTAKE STRUCTURE	MR. August described ARRANGEMENT AS SHOWN.	
OUTLET STRUCTURE	Could not be FOUND. Believed to be covered by SILT AND debris.	
OUTLET CHANNEL	BAIT POND	
EMERGENCY GATE	VALVE SUBMERGED IN RESERVOIR.	Reportedly operated occassionally.

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	TRAPEZOIDAL CUT WITH 2-15" DIA. CMP.	See Photographs AND PLATE E-2.
APPROACH CHANNEL	EARTHEN CUT.	Approach LOSSES SIGNIFICANT AT NORMAL POOL ELEVATION
DISCHARGE CHANNEL	NOT WELL-defined THROUGH SWAMP.	
BRIDGE AND PIERS	BRIDGE: RIGHT ABUTMENT is EMBANKMENT. LEFT ABUTMENT is WATER HEATER TANK.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE AT SITE	
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER	NONE AT SITE	

DOWNSTREAM CHANNEL

Sheet 1 of 1

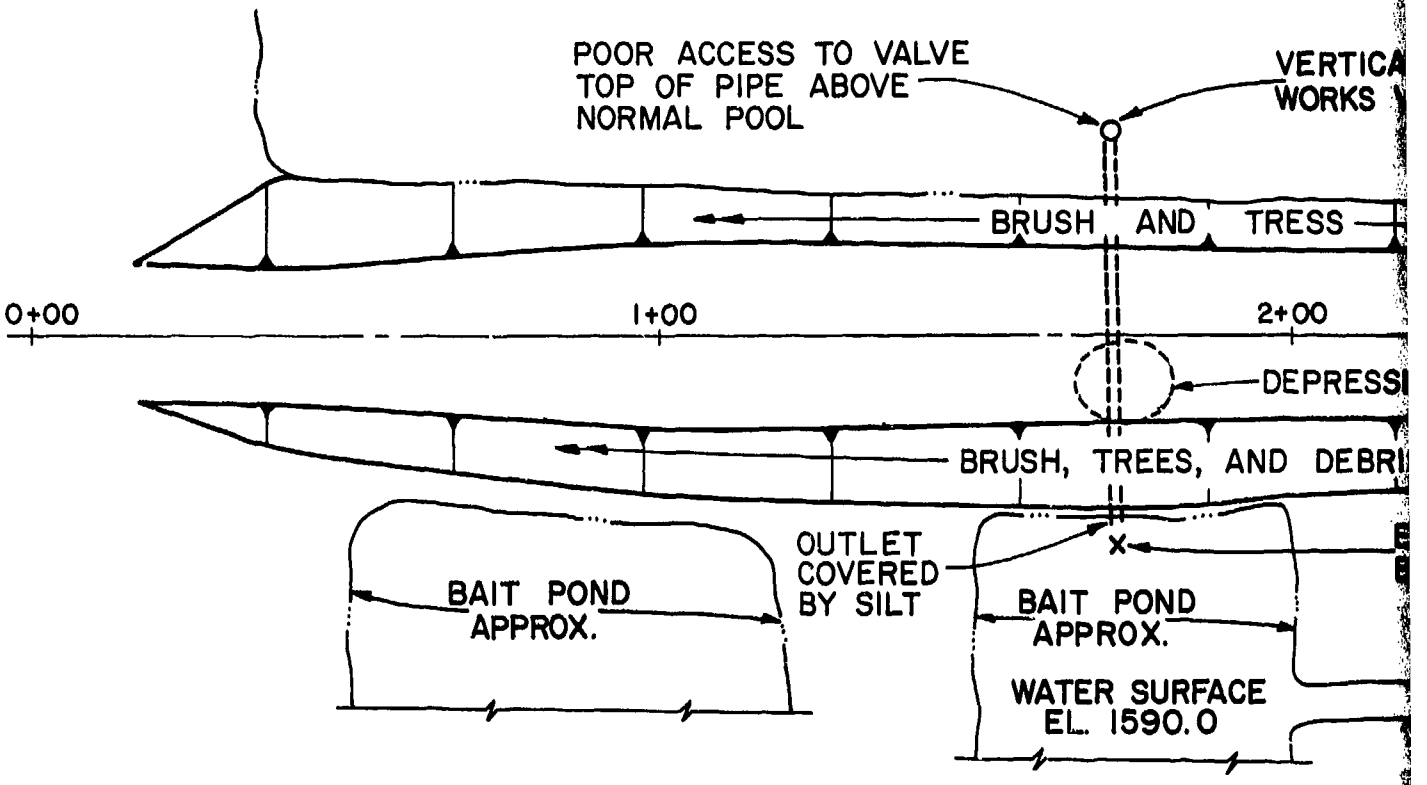
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: **Obstructions** **Debris** **Other**	BAIT PONDS	
SLOPES	RELATIVELY STEEP	
APPROXIMATE NUMBER OF HOMES AND POPULATION	7 dwellings AND 1 unused store downstream of PA-590 embankment	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Generally Mild	
SEDIMENTATION	No observed or Reported Problems	Reservoir not fully cleared. Stumps protrude.
WATERSHED DESCRIPTION	Mostly wooded	Minor development

INSPECTION DATE: 2 JUNE 1981
POOL ELEVATION 1595.6



PLAN

SCALE: 1 IN. =

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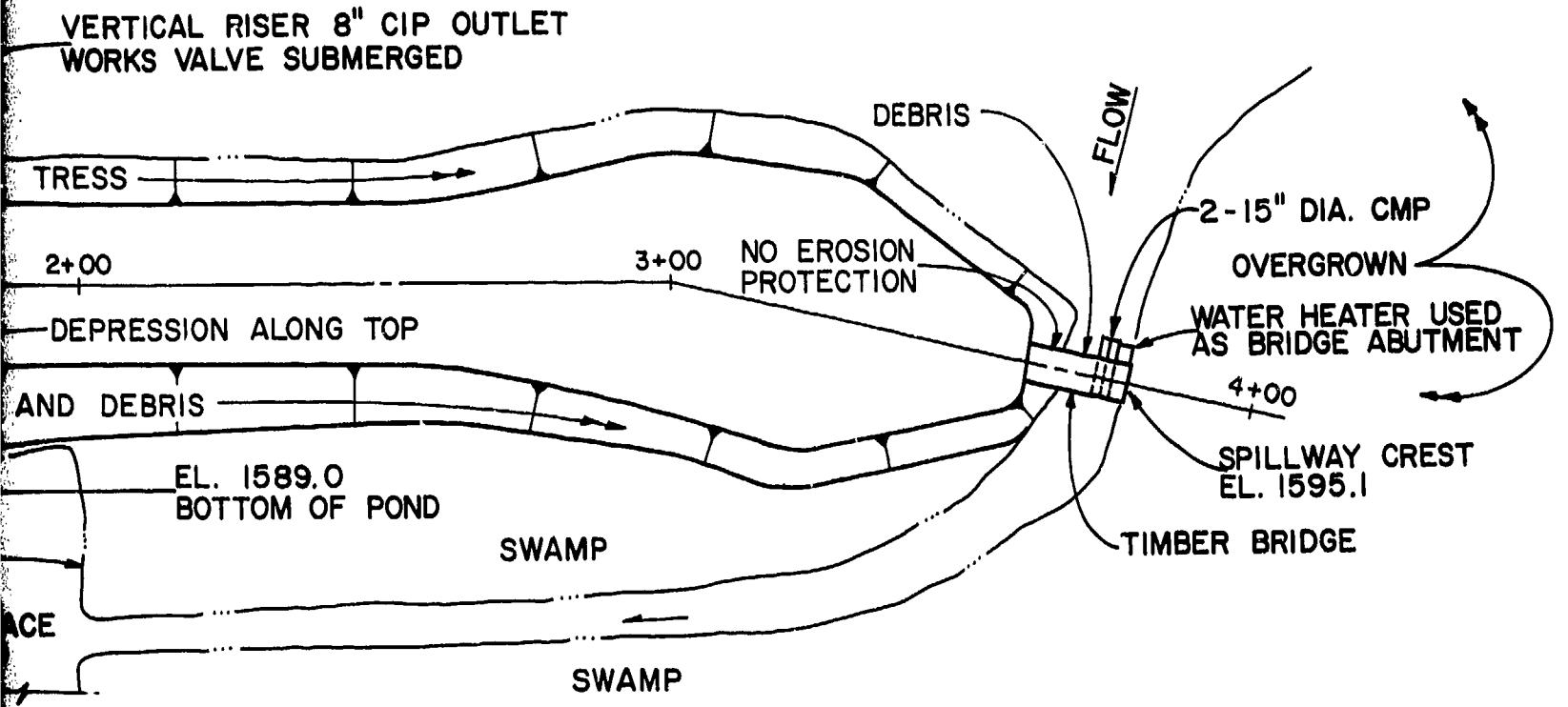


PLAN

SCALE: 1 IN. = 30 FT.

0 30 60

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELMCREST DAM

MRS. LOUISE BOEZI

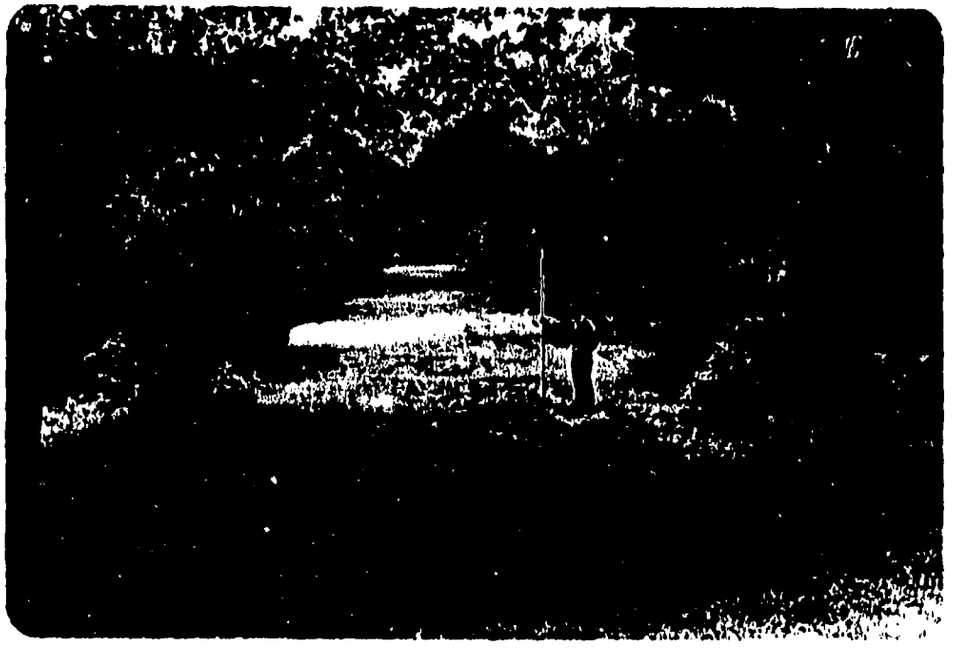
RESULTS OF
VISUAL INSPECTION

JULY 1981 EXHIBIT B-1

APPENDIX C

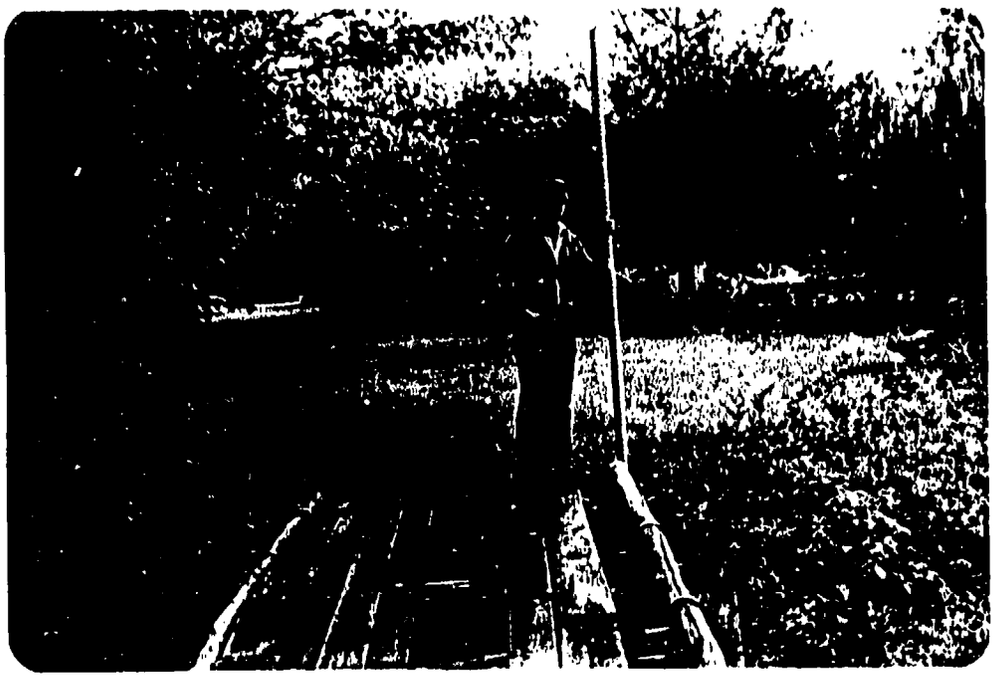
PHOTOGRAPHS

ELMCREST DAM

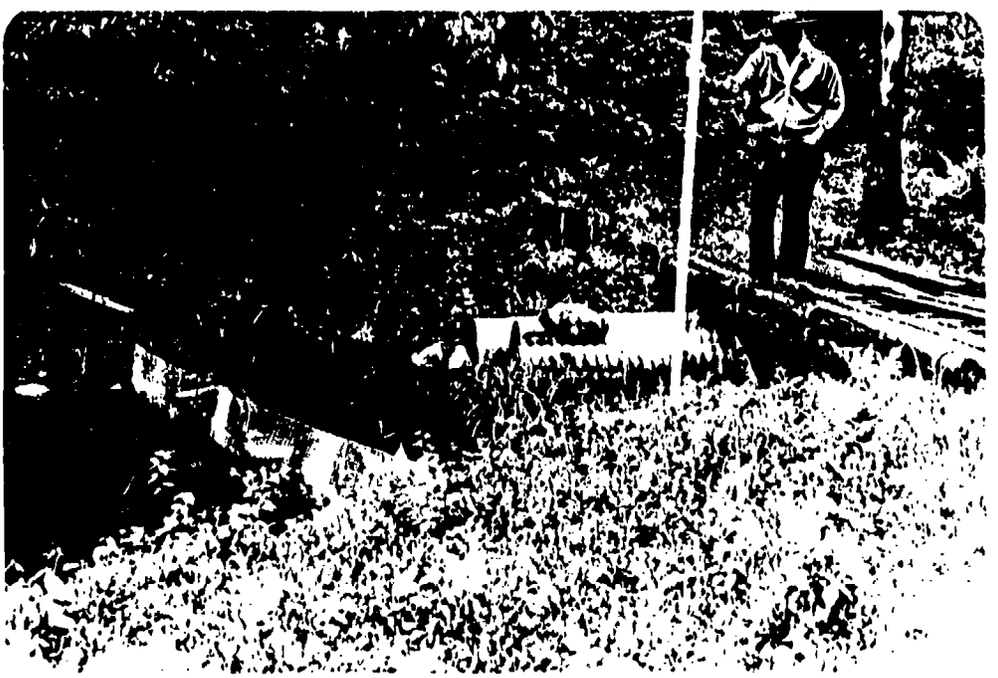


A. Embankment - View From Right Abutment

B. Depression on Top of Embankment

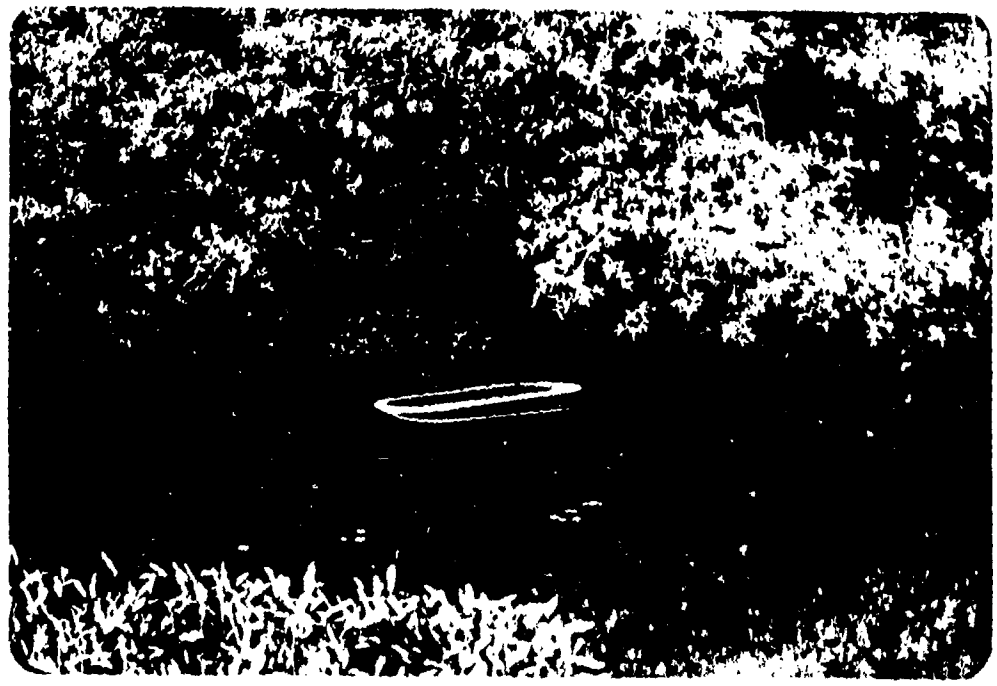


C. Embankment - View From Spillway

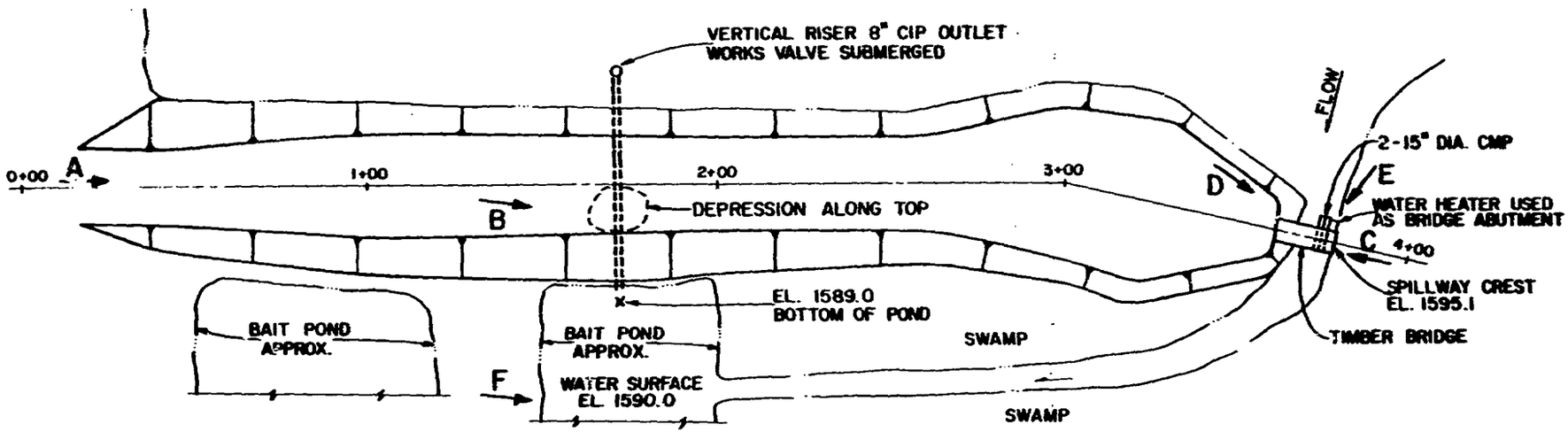


D. Spillway and Approach Channel

E. Spillway



F. Confluence of Spillway Exit Channel and Bait Pond



← LOCATION AND ORIENTATION OF CAMERA

A PHOTOGRAPH IDENTIFICATION LETTER

NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELMCREST DAM

MRS. LOUISE BOEZI

GUIDE TO LOCATION OF PHOTOGRAPHS

JULY 1981

EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

SUSQUEHANNA River Basin
Name of Stream: TRIBUTARY TO ROARING BROOK
Name of Dam: ELMCREST
NDI ID No.: PA-00347
DER ID No.: 35-142
Latitude: N 41° 23.0' Longitude: W 75° 31.8'
Top of Dam Elevation: 1597.9
Streambed Elevation: 1589.0 Height of Dam: 8.9 ft
Reservoir Storage at Top of Dam Elevation: 283 acre-ft *
Size Category: SMALL
Hazard Category: (see Section 5)
Spillway Design Flood:

* OF WHICH 47 ACRE-FT IS IMPOUNDED NATURALLY

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
	NONE			

DOWNSTREAM DAMS

	NONE UNTIL ROARING BROOK.			
	DAM(S) ON ROARING BROOK			
	WOULD NOT BE AFFECTED.			

SUSQUEHANNA River Basin

Name of Stream: TRIBUTARY TO ROARING BROOK

Name of Dam: ELMCREST

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A	0.31	0.62	1.50	N/A	N/A	0.53	1.02	11	E
Total	0.31								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

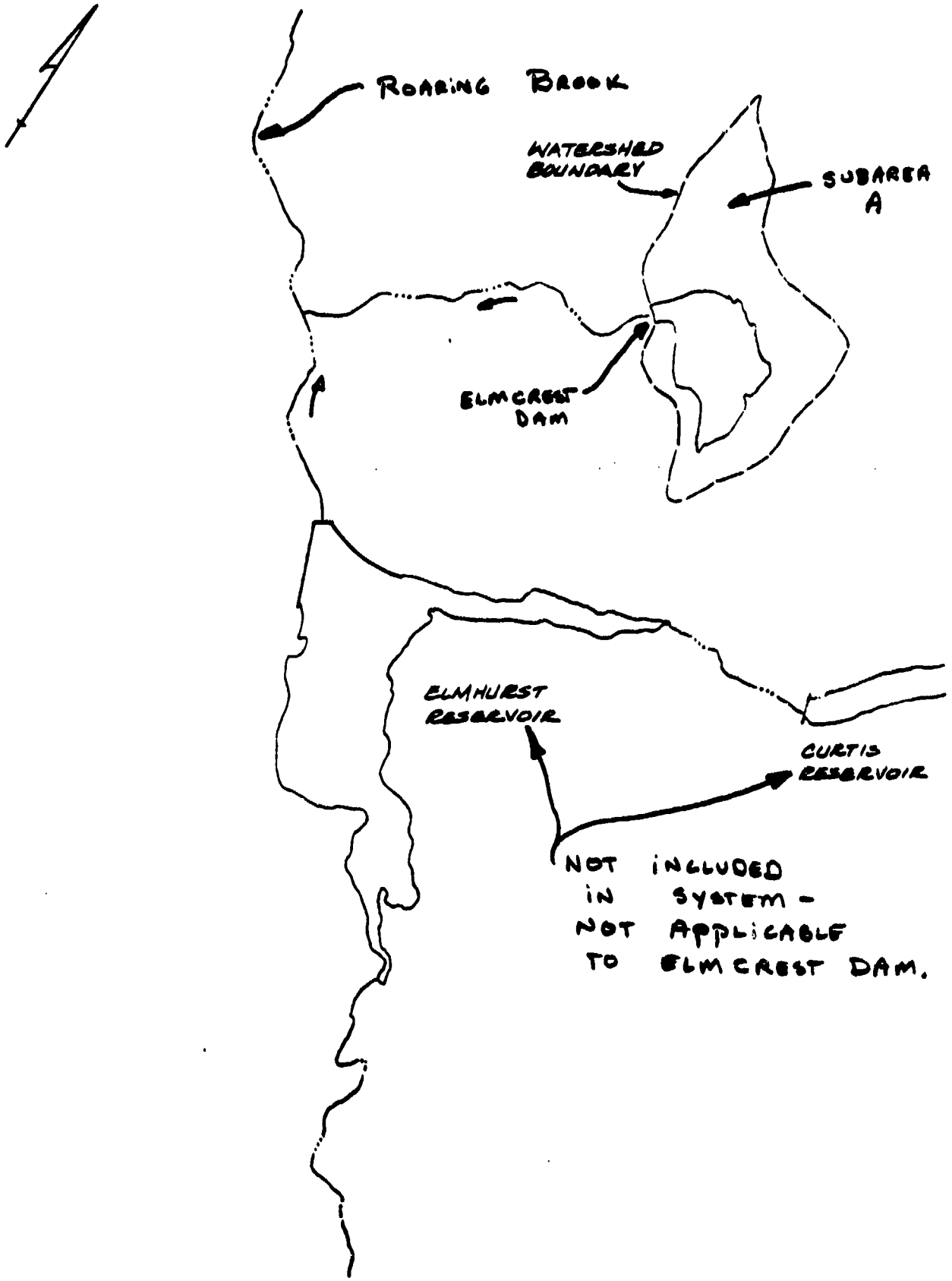
RAINFALL DATA:

PMF Rainfall Index= 22.15 in., 24 hr., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	N/A
Geographic Adjustment Factor:	96%	1.0
Revised Index Rainfall:	21.3	N/A

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	118
12 hours	127
24 hours	136
48 hours	142
72 hours	145
96 hours	N/A



SKETCH OF SYSTEM

Data for Dam at Outlet of Subarea A (See sketch on Sheet D-4)

Name of Dam: ELMCREST

STORAGE DATA:

Elevation	Area (acres)	Storage million gals	Storage acre-ft	Remarks
1575.0 =ELEVO	0	0	0	DATA FROM OWNER
1589.0 =ELEV1	10 =A1		47 =S1*	STREAMBED AT TOE
1595.1	24		174	SPILL. CREST
1597.9	44		293	TOP DAM
1600.0 **	53			

* S1 = A1 (ELEV1 - ELEVO)/3

** Planimetered contour ~~at least 10 feet~~ above top of dam

Reservoir Area at Normal Pool is 17 percent of subarea watershed.

BREACH DATA:

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A

Name of Dam: ELMCREST

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	SEE	
Spillway Crest Elevation	NEXT	
Spillway Head Available (ft)	SHEET	
Type Spillway		
"C" Value - Spillway		
Crest Length - Spillway (ft)		
Spillway Peak Discharge (cfs)		
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve:

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

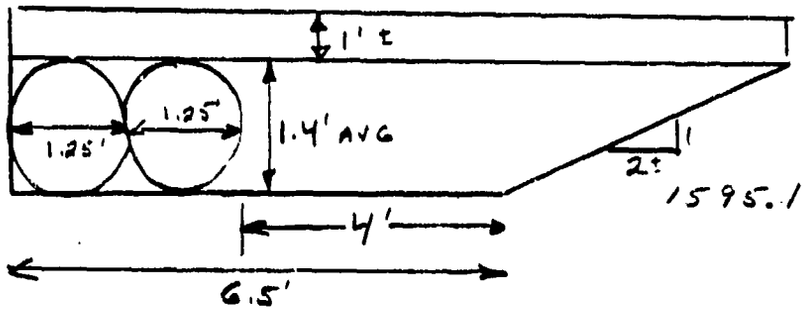
OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	1589 +/-		
Invert of Inlet	1596 +/-		
Type	CIP		
Diameter (ft) = D	0.67		
Length (ft) = L	70'		
Area (sq. ft) = A	0.35		
N	.014		
K Entrance	0.5		
K Exit	1.0		
K Friction=$29.1N^2L/R^{4/3}$	4.35		
Sum of K	5.85		
$(1/K)^{0.5} = C$	0.41		
Maximum Head (ft) = HM	8 +/-		
$Q = CA\sqrt{2g(HM)}$ (cfs)	3.3		
Q Combined (cfs) $\approx$	3		

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

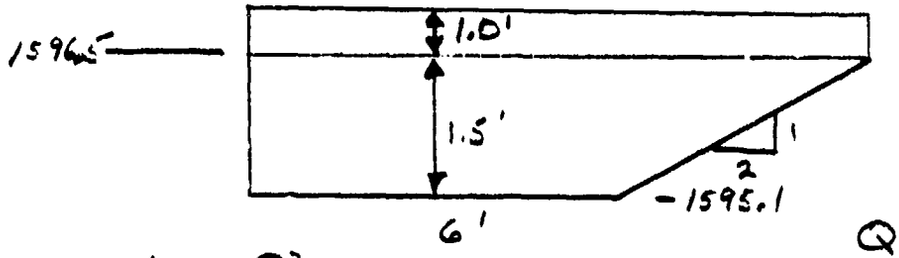
CHKD BY _____ DATE _____ JOB. NO _____

Spillway

Approach losses are judged appreciable for low flows and less for pool near top of dam.



The following is judged to be an equivalent section:



A = Flow area

T = Top width

Q = Flow (cfs)

$$Q = \frac{2.7}{3.1}\sqrt{\frac{A^3 g}{T}}$$

$$hv = \frac{Q^2}{2gA^2}$$

Pool = hv + depth + 1595.1

depth	T	A	Q	hv	Pool
0	6	0	0	0	1595.1
0.5	7	3.25	11	.18	1595.8
1.0	8	7	32	.33	1596.4
1.5	9	11.25	62	.47	1597.0

[Change to pressure flow $Q = CA\sqrt{2gH}$ $C = 0.7$

H = Pool elev − (1595.1 + 1596.5)/2]

82	1597.5
92	1597.9
113	1599.0
129	1600.0

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

Selected Computer Output

Index

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1                              NATIONAL DAM INSPECTION PROGRAM
    2                A2                                 TRIPUTARY TO ROARING BROOK
    3                A3                                    ELMCREST DAM
    4                B     300       0       15       0       0       0       0       0      -4       0
    5                B1      5
    6                J       1       5        1
    7                J1      1      .5       .4       .3       .2
    8                K       0       1                                        1
    9                K1        RUNOFF INTO ELMCREST LAKE
   10                M       1       1      .31              .31                                    1
   11                P               21.3     118      127     136      142     145
   12                T                                                 1.0     .05             .17
   13                U    1.02    0.62
   14                X    -1.5   -0.05      2.0
   15                K       1       1                                        1
   16                K1        ROUTE THROUGH ELMCREST DAM
   17                Y                                1       1
   18                Y1      1                                                -1595.1     -1
   19                Y4 1595.1  1595.8  1596.4  1597.0  1597.5  1597.9  1599.0  1600.0
   20                Y5      0      11      32      62      82      92     113     129
   21                SA      0      10      34      53
   22                SE   1575    1589  1595.1    1600
   23                SS 1595.1
   24                SD 1597.9
   25                SL      0     112     162     262     287
   26                SV 1597.9    1598  1598.1  1598.8    1600
   27                K      99
```

D-9

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50	RATIO 3 .40	RATIO 4 .30	RATIO 5 .20
HYDROGRAPH AT	1	.31	1	1112.	556.	445.	333.	222.
	(	.80)	(	31.49)(	15.74)(	12.59)(	9.44)(	6.30)(
ROUTED TO	1	.31	1	876.	204.	92.	73.	44.
	(	.80)	(	24.80)(	5.78)(	2.61)(	2.07)(	1.25)(

SUMMARY OF DAM SAFETY ANALYSIS

ELDORADO DAM

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1595.10	1595.10	1597.90
STORAGE	174.	174.	283.
OUTFLOW	0.	0.	92.

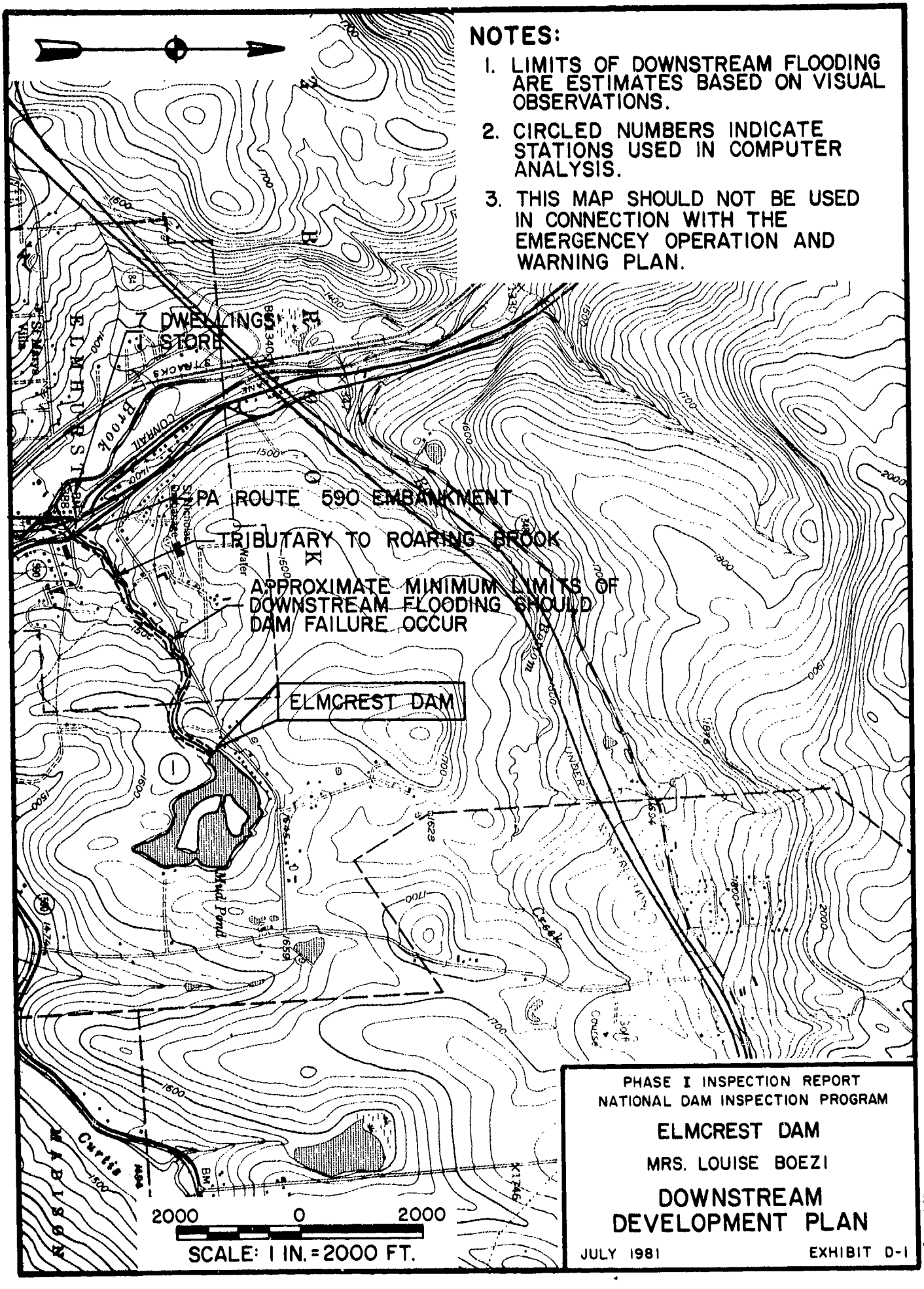
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1599.10	1.20	339.	876.	7.75	41.25	0.00
.50	1598.32	.42	302.	204.	4.75	43.00	0.00
.40	1597.90	.00	283.	92.	.25	43.50	0.00
.30	1597.28	0.00	256.	73.	0.00	43.50	0.00
.20	1596.64	0.00	230.	44.	0.00	43.50	0.00

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

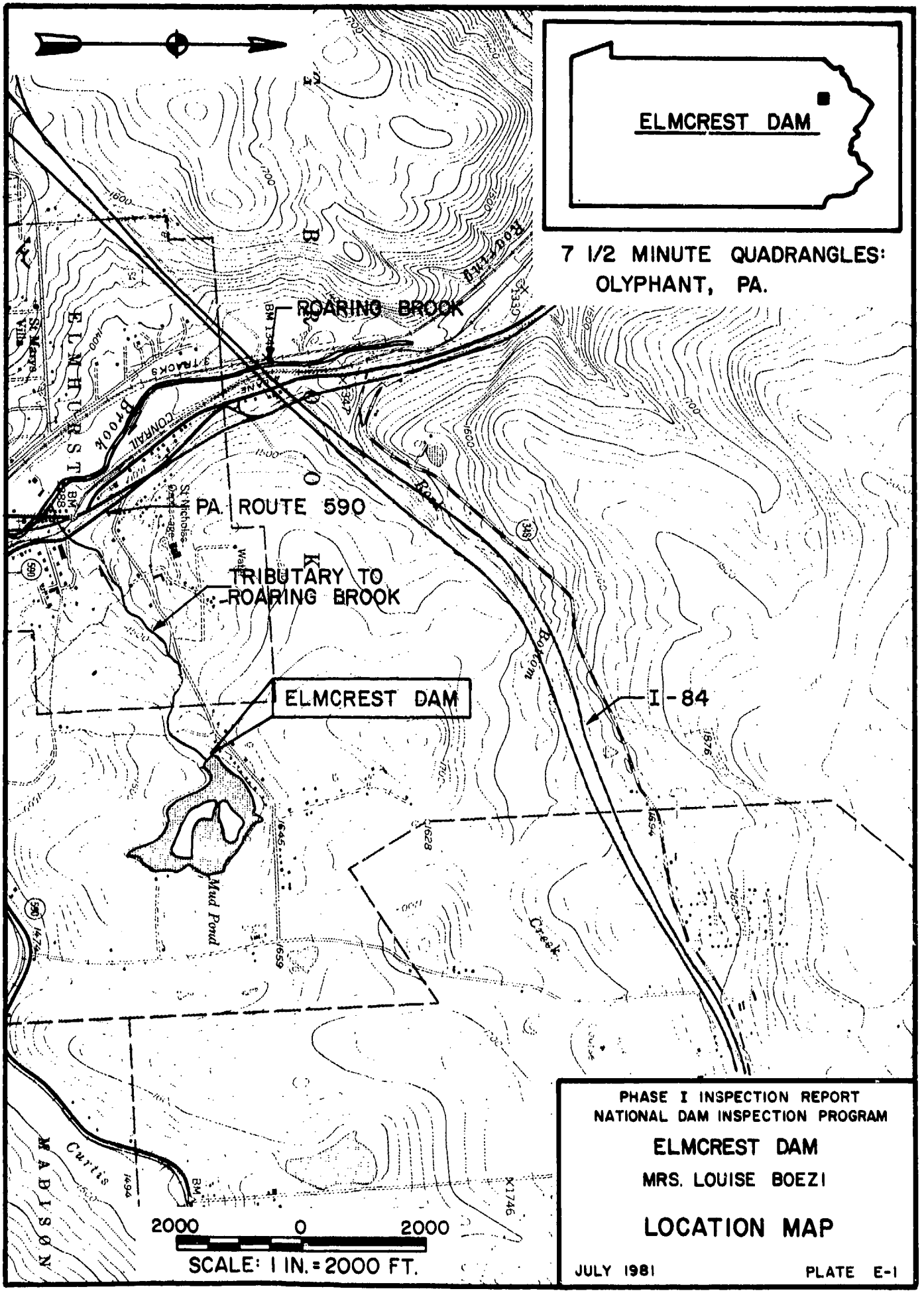
Summary of Pertinent Data

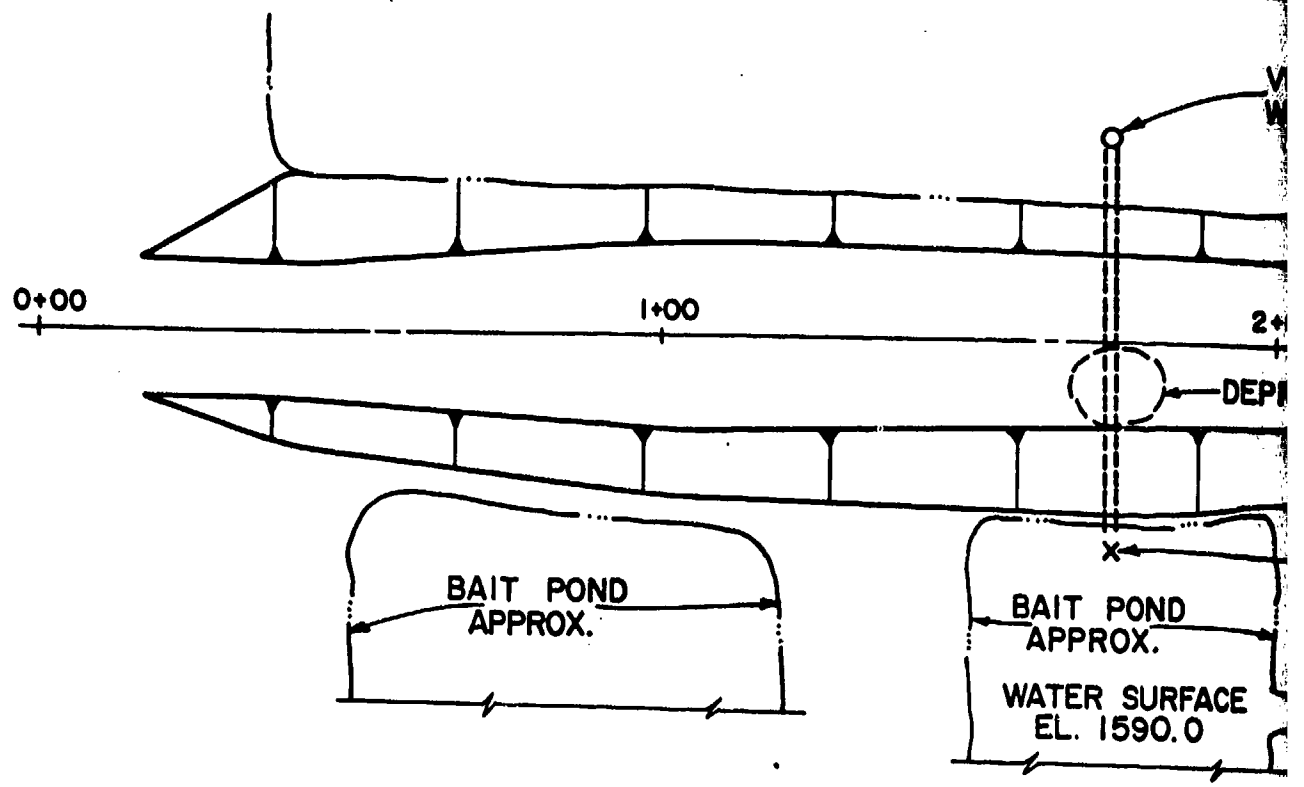
	PMF	½ PMF = SDF
Rainfall (inches)	24.71	—
Runoff (inches)	22.56	11.28
Elmcrest Dam		
Peak inflow (cfs)	1112	556
Peak outflow (cfs)	876	204
Depth of overtopping (ft)	1.20	.42
Duration of overtopping (hrs)	7.75	4.75


NOTES:
1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCEY OPERATION AND WARNING PLAN.
7 DWELLINGS
1 STORE
PA ROUTE 590 EMBANKMENT
TRIBUTARY TO ROARING BROOK
APPROXIMATE MINIMUM LIMITS OF DOWNSTREAM FLOODING SHOULD DAM FAILURE OCCUR
ELMCREST DAM
Mud Pond
Curtis
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ELMCREST DAM
MRS. LOUISE BOEZI
DOWNSTREAM DEVELOPMENT PLAN
JULY 1981
EXHIBIT D-1

APPENDIX E

PLATES


ELMCREST DAM
7 1/2 MINUTE QUADRANGLES:
OLYPHANT, PA.
ROARING BROOK
PA. ROUTE 590
TRIBUTARY TO
ROARING BROOK
ELMCREST DAM
I-84
Mud Pond
ELMHURST
MADISON
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ELMCREST DAM
MRS. LOUISE BOEZI
LOCATION MAP
JULY 1981
PLATE E-1



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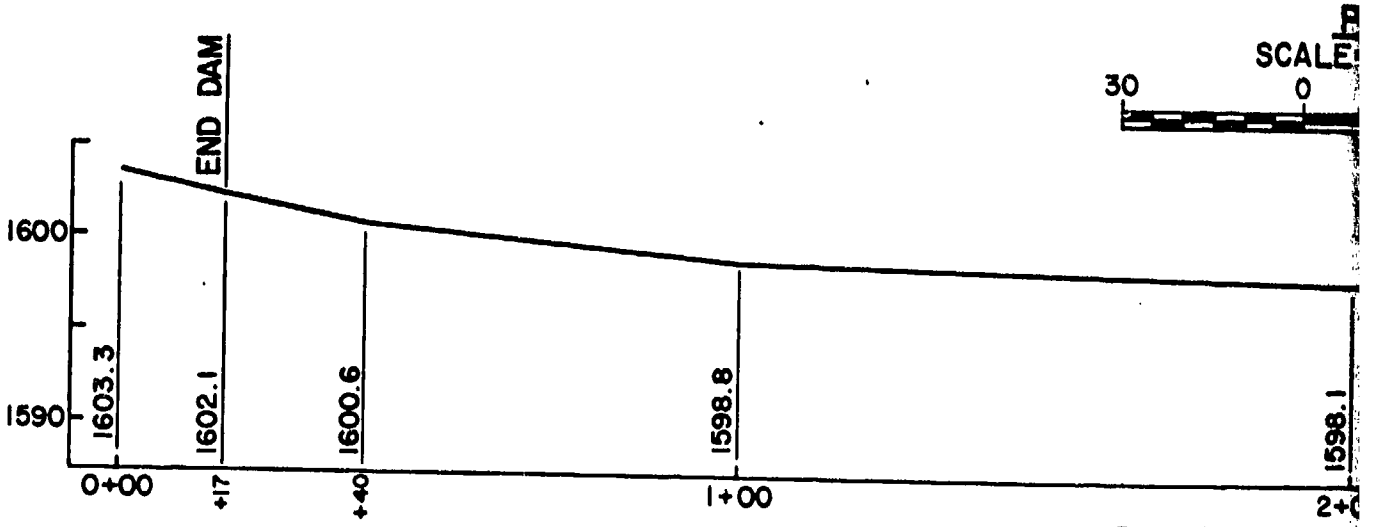
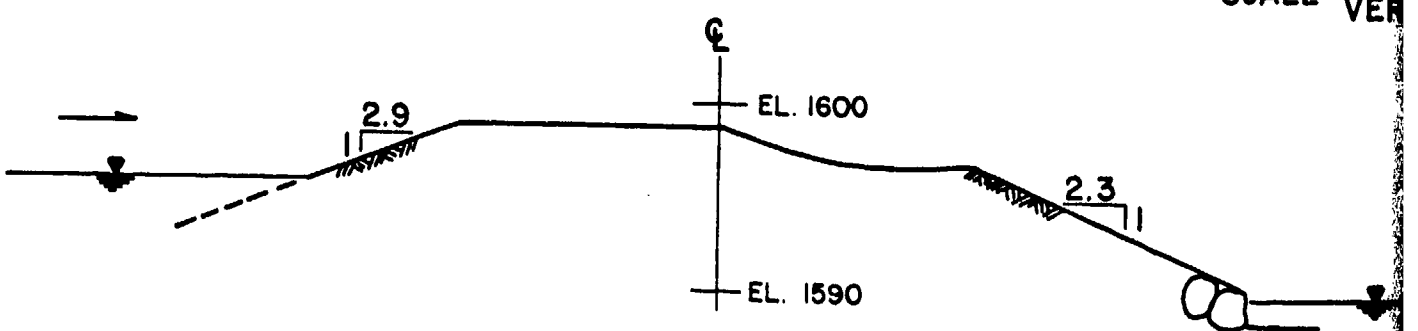


PROFILE-LOO

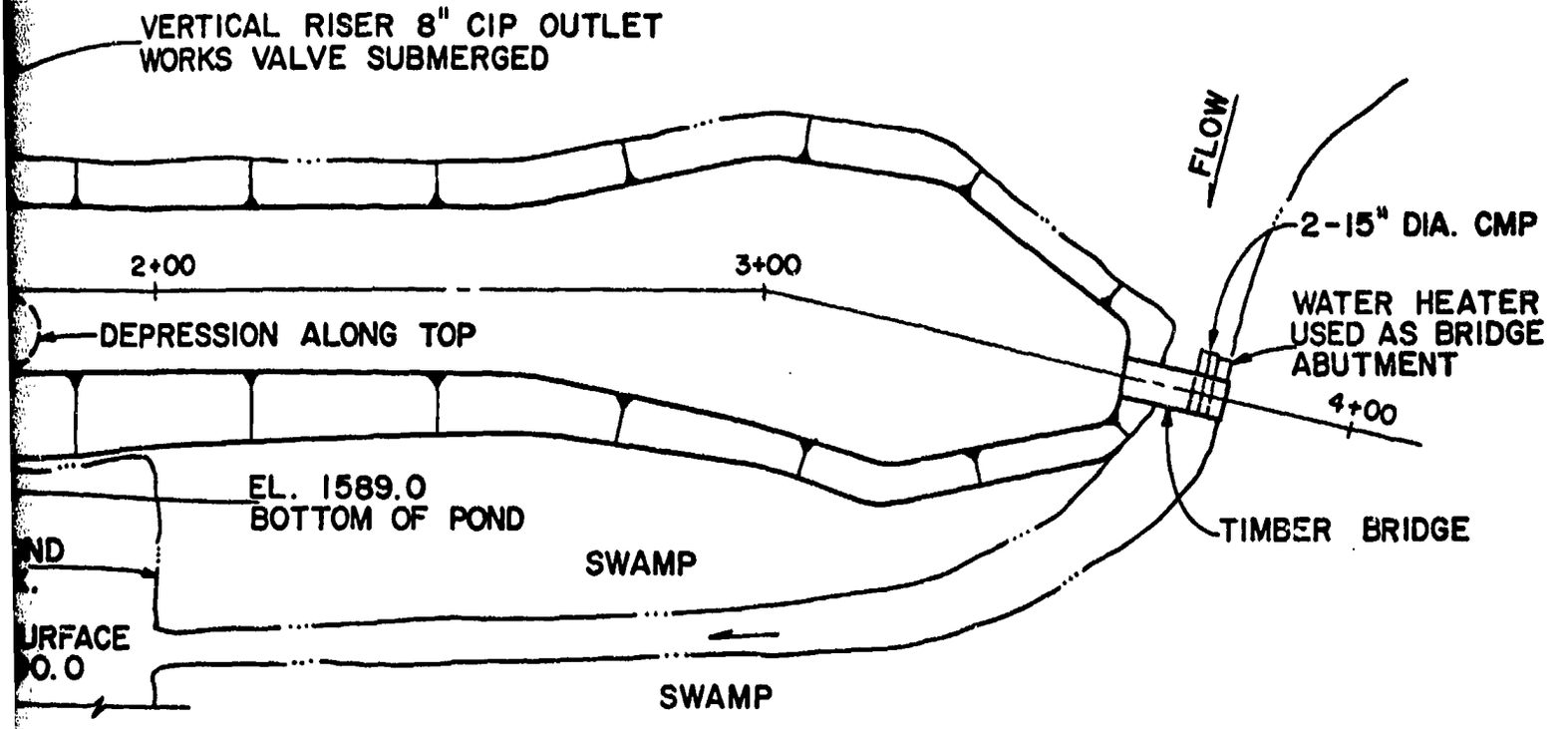
SCALE: HOR
VER



SECTION AT STATION 1+72

SCALE: 1 IN. = 10 FT.

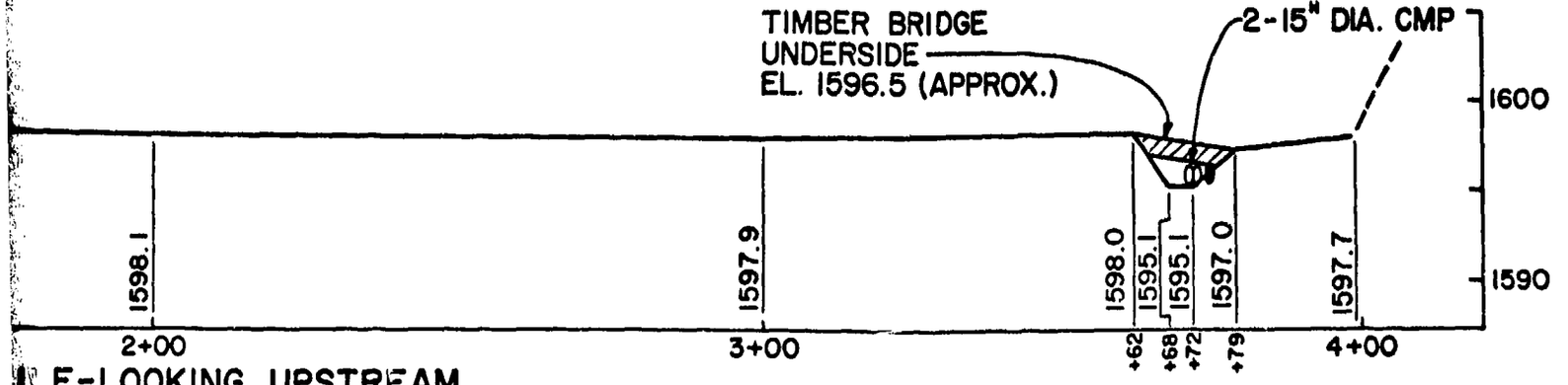
10 0 10 20



PLAN

SCALE: 1 IN. = 30 FT.

0 30 60



LE-LOOKING UPSTREAM

ALE: HORIZ.- 1 IN. = 30 FT.
VERT.- 1 IN. = 10 FT.

BAIT POND

NOTE:

THIS PLATE WAS DRAWN FROM LIMITED SURVEY INFORMATION OBTAINED FOR THIS INSPECTION; IT SHOULD NOT BE CONSIDERED DEFINITIVE.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELMCREST DAM

MRS. LOUISE BOEZI

PLAN, PROFILE AND SECTION

JULY 1981 PLATE E-2

APPENDIX F

GEOLOGY

ELMCREST DAM

APPENDIX F
GEOLOGY

The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene Time. The general direction of ice movement was S 35° - 40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70°E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

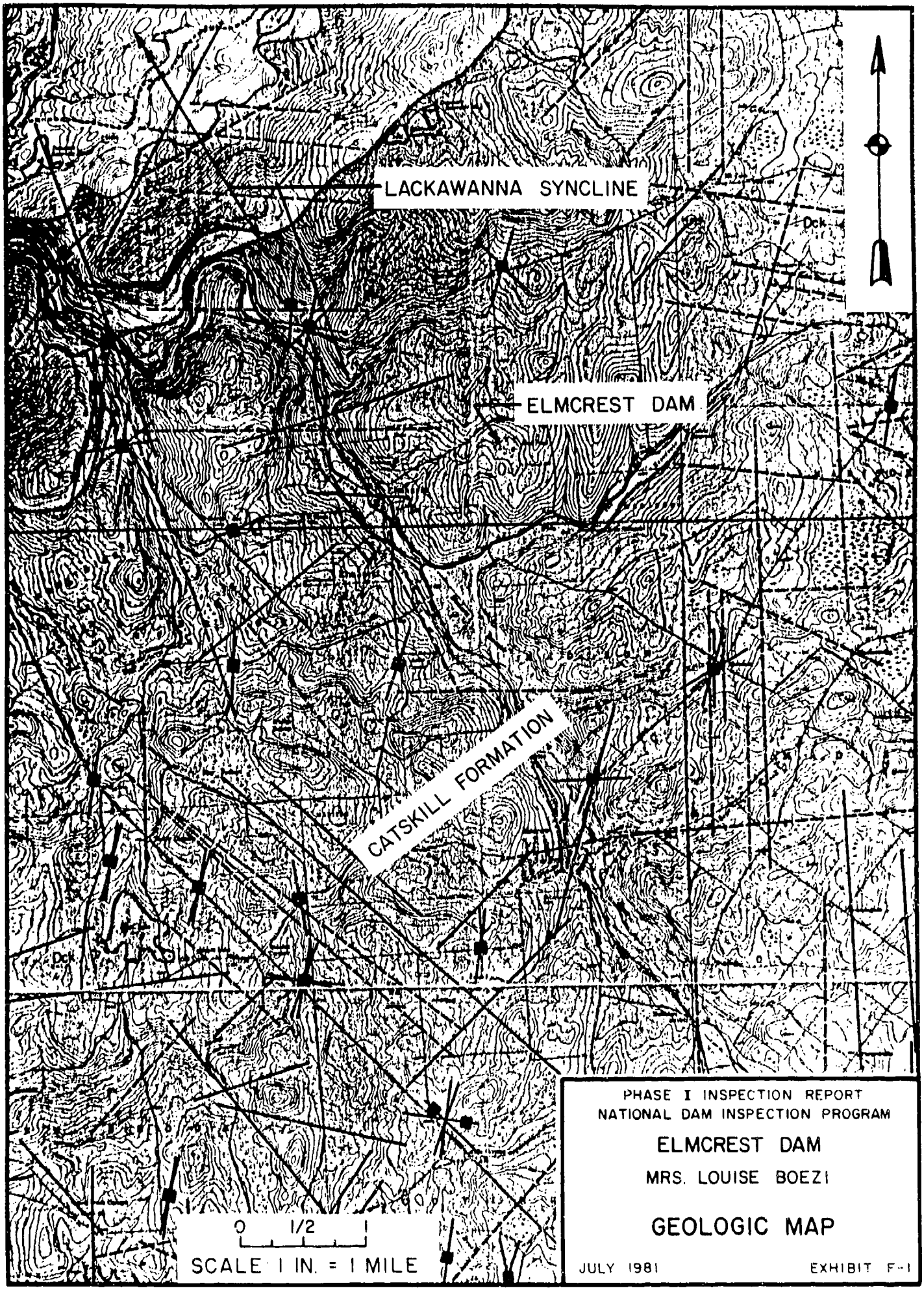
The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brook, and Spring Brook, have cut deep canyons through the mountains and follow a tortuous course to their confluence with the Lackawanna River near Scranton. Northwest of the Lackawanna River, the mountains rise abruptly to a sharp ridge which in most places is somewhat higher than the country to the northwest. Consequently, most of the drainage in this part of the country flows westward by way of Tunkhannock Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono

sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

Elmcrest Dam is underlain by the Poplar Gap Member of the Catskill Formation. The Poplar Gap Member is predominantly a gray sandstone and conglomeratic sandstone with interbedded siltstones and shales. Sandstones present are thick-bedded, fine-to coarse-grained and exhibit very low primary porosity due to a clay and silica matrix. Effective porosity results from fractures and parting planes. Conglomeratic sandstone occurs primarily as concentrates of sub-round to round quartz pebbles. The siltstones and shales at the site are thin-bedded and also have low porosity.

The rocks are well-indurated and generally are not susceptible to slope failure; however, the presence of well-developed bedding and joint planes will result in some rockfall from vertical and high-angle cut slopes.

Bedrock is entirely overlain by glacial till of Late Wisconsin Age. This till is an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 5 to 75 feet. The available information indicates that the dam is founded on stiff yellow clay, which is part of this till.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ELMCREST DAM

MRS. LOUISE BOEZI

GEOLOGIC MAP

JULY 1981

EXHIBIT F-1